REAL-TIME LANE DETECTION FOR DRIVING SYSTEM USING IMAGE PROCESSING BASED ON EDGE DETECTION AND HOUGH TRANSFORM

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ABSTRACT

Real-time Lane Detection for Driving System Using Image Processing Based on Edge Detection and Hough Transform has been developed to aid a driver in the lane departure decision-making, to reduce a loss of concentration and to prevent an accident while driving. In this paper, we propose a method for detecting the lane markers in real time by using a webcam camera to record the road as a video stream file (.avi). The Edge detection is a technique which used to identify points into a set of curved line segments called edge. Hough Transform method is used to detect the lanes in an image for increasing the accurate lane detection and the safety driving system. The results show the performance of the proposed lane detection and tracking algorithm in various lane road conditions on video clip that used for testing. According to the results, the driver can use this information to increase their safety driving, especially when making the decision of lane changing.

KEYWORDS

Real-time, Lane detection**,** Hough Transform, Edge detection, Image processing and Webcam camera

1 Introduction

Nowadays, the growing volume of the traffic all around the world requires higher levels of the traffic safety [1]. On the road, there are so many unsafe driving cars that the driver requires more careful while driving. Important for driver is being careful when he/she must change lane, especially in new driver who absolutely cannot keep too much information at once and has no confidence for driving [2]. Driver may be loss of concentration and control car. In fact, human behaviors are indeed hard to recognize, predict and handle by current available equipment. Therefore, a monitoring and warning system focusing on the vehicle behaviors are needed while the car is moving on the road [3].

Based on the previous work done in lane detection field. A Hough transform and Edge detection, basic techniques for image processing, are used for detecting lane marks that can reduce the loss of views to the front street in real time. The system is designed to work in conjunction with the general principles of the webcam image processing [4]. The algorithm helps the driver by increasing decision-making while driving [5] in order to monitor the movement of vehicles through the lane and estimate the lane more efficient than previous work.

In this paper, the lane detection algorithm is proposed by using information of camera and road. Firstly, the acquired video stream file is extracted to image frames. Secondly, converting RGB image to an intensity image and then to Y'CbCr image. Thirdly, creating an image filter to implement and detect edges. Fourthly, setting threshold to make a binary image. Fifthly, using Hough transform and Hough lines to detect road lane markers and defining the analytic areas. Finally, several experiments are conducted to demonstrate the effectiveness of the proposed algorithm [6].

The concept of this paper is to provide information of lane detection, tracking and warning system for improving the safety

driving system in real time. The system works from using computer to monitor the road, detect and tract its lane markers in various areas, and notify the driver if they cross the lane.

2 METHOD DESCRIPTION

2.1 Image processing

Digital Image Processing converts image data into digital data in order to bring information through various processes in a computer. The computer system, input or output data needs to be in digital format only. In the digital image processing, the system receives image data, then calculates it, and finally output digital image data. To store image data into the computer's memory can be performed by reservation the memory of the machine in the form of an array. The value in each array represents the quantity of pixel. The position of the image is determined by the position of the array.

2.2 Hough Transform

The Hough transform is a popular technique which can be used to isolate features of a particular shape within an image. In this work, it is used for detecting line road as lane detection. There are 2 methods for computing the Standard Hough transform (SHT) of the binary image BW, which is an algorithm of parameter matrix whose rows and columns correspond to rho(ρ) and theta(θ) values respectively. The first method is given below:

$$[H, \theta, \rho] = \text{hough}(BW) \quad (1)$$

For detect lines in the image. The second method is adding parameter name and value pairs in the same equation as follow:

$$[H, \theta, \rho] = \text{hough}(BW, \text{ParameterName}, \text{ParameterValue}) \quad (2)$$

When ParameterName is RhoResolution, specify a real scalar value between 0 and norm (size (BW)), to determine the spacing of the Hough transform bins along the rho axis. The default value is 1. When ParameterName is Theta, specify a vector of Hough transform theta(θ) values. The acceptable range of theta(θ) values is $-90° \leq \theta < 90°$.

The Standard Hough Transform (SHT) uses the line parametric as follow:

$$\rho = x*\cos(\theta) + y*\sin(\theta) \quad (3)$$

The variable rho (ρ) is the distance from the origin to the line along a vector perpendicular to the line. Theta (θ) is the angle of the perpendicular projection from the origin to the line. The range of Theta (θ) is. $-90° \leq \theta < 90°$. The angle of the line is $\theta + 90°$. It measured in degrees clockwise from the positive *x*-axis [9].

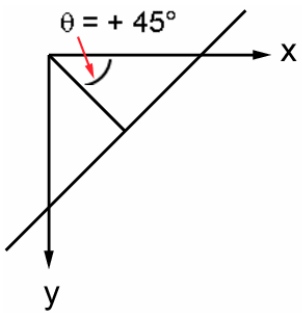


Figure 1. The algorithm of Hough function

SHT computes accumulator cells which are equal to zero at the first. Then, for non-background point in the image, rho (ρ) is calculated for every theta (θ). At the end of this procedure, in SHT, *Q* value points in

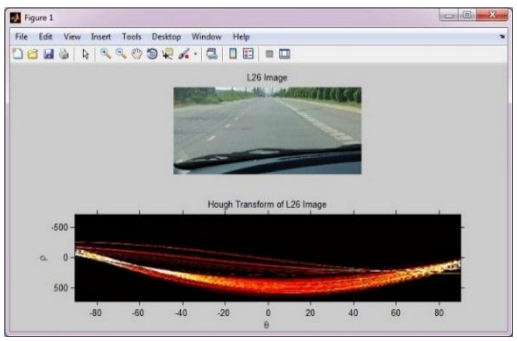


Figure 2. Detecting line road by using the Hough transform

the *xy*-plane lie on the line specified by theta(c) and rho(r). Peak values in the SHT represent potential lines in the input image.

2.3 Edge Detection

Edge Detection is used in the field of image recognition and image analysis including identification of objective region and pick-up of region shape [7]. It is very important for image processing because it used for tracing boundary of the target and background object. In this paper, it works in conjunction with the Hough transform in order to compute lane detection more accurate. Its advantages are good localization with minimal distance between the detected and actual edge position, eliminate multiple segments and instead create a single longer edge [8].

(a) Original (b) Edge (c) Overlay

Figure 3. Edge Detection Algorithm.

2.4 Local Maxima Finder

The Local Maxima Finder object is a function that uses to find the peaks in the Hough transform. After constructing the object and optionally setting properties, researchers use the step method to find the coordinates of the local maxima in the input image frame form the video stream. Use the step syntax as describe below with input matrix, I, LocalMaximaFinder object, H, and any optional properties. [9]

H = vision.LocalMaximaFinder (4)
(MAXNUM, NEIGHBORSIZE, *Name, Value*)

From a construction above, it returns a local maxima finder object, H, with the MaximumNumLocalMaxima property, which finds a positive scalar integer value, set to MAXNUM, NeighborhoodSize property, which specifies the size of the neighborhood around the maxima as a 2-element vector of positive odd integers, set to NEIGHBORSIZE, and other specified properties set to the specified values. [9] Researchers specify the value of MaximumNumLocalMaxima at 1 and NeighborhoodSize at [7] respectively.

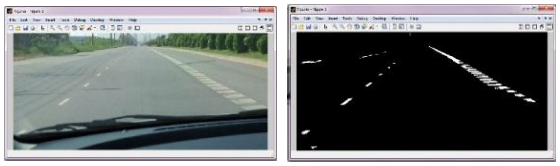
2.5 Hough lines

This method is used for extract line segments in the image based on Hough transform. There are 2 functions to describe the meaning of parameter and how to search the line segment. The first function is given below:

lines = houghlines(BW, θ, ρ, peaks) (5)

Where BW associated with particular bins in a Hough transform. theta(θ) and rho(ρ) are vectors returned by function hough. peaks is a matrix returned by the houghpeaks function which contains row and column coordinates of the Hough transform. Then, using parameter/value pairs as follow:

lines = houghlines(…, param1, val1,
param2, val2) (6)



(a) Road part image b) Extracted line Segment image

Figure 4. Example of Hough lines

It specifies the distance between two line segments with the same Hough transform bin. If its distance less than the value specified, the houghlines function will merge the line into a single line. [6]

2 PROPOSED METHOD

In this paper, the main components of driving system detection based on the Hough transform are webcam camera and computer for storing image data. Firstly, the system saves image data from webcam camera and then transfers it into frame grabber process in the computer. Secondly, in recording data, real-time is applied to image data (.avi). Then the program which analyzes the image data in a video signal will be taking the recorded data to further processing. The idea of this project is to provide a computer to monitor the image of line road that has intruded. The surveillance will be notified when car crosses the line. The processes are described below:

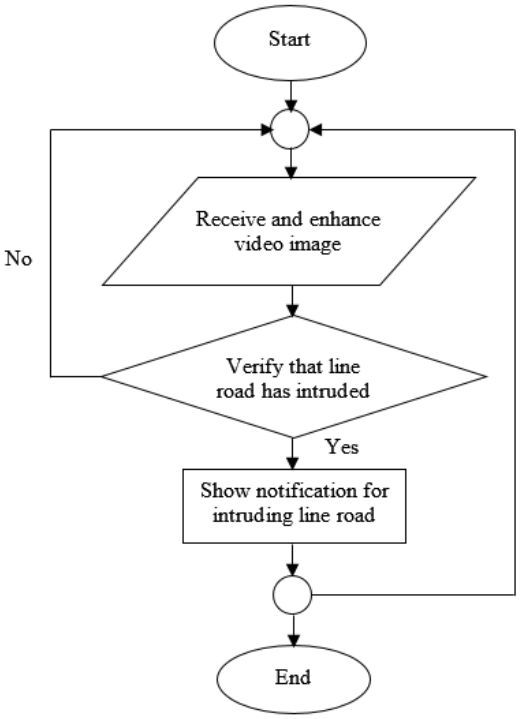


Figure 5. Frame work of Real-time lane detection for driving system Using Image Processing Based on Edge detection and Hough transform.

From Figure 5. shows the main process of Real-time Lane Detection of Driving System Based on Hough transform. The proposed method of lane detection and tracking road lane markers in a video sequence are describe as steps below:

Step1: Receiving video stream file: the developed system is able to acquire images from video stream files, which are already saved in a form of .avi file, by create video file reader system object to read video from a file. This is the first step in the algorithm. The image will be the same size as the resolution of the camera that used to record without any additional configuration.

Step2: **Splitting image frame**: this process start after receiving image. The system analyzes the video file to apply to the video frames splitting process. By applying the data of video files, which are stored in the stacked array, then the system specifies the variable to divide sub frames in the variable of array image to the frame. When finished dividing all the frames, the system will keep all the frames in the frame buffer which is displayed in the storage module for analysis in the next process.

Step3: Converting RGB image: From RGB image, we have to convert it to an intensity image and Y'CbCr image respectively for more easily processing in the next process.

Step4: Detecting Edges: From step3, a 2-D filter is implemented by an image filter system object for detecting edges in the input video.

Step5: Setting threshold: From step4, the input intensity image is converted to a binary image by an auto threshold system object. We set threshold at 75.

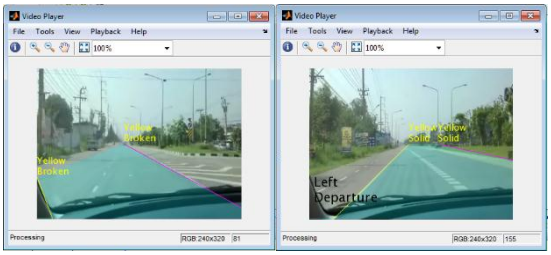
Step6: Computing Hough transform: From step 5, the system operates the defined segment to analyze the Hough transform. We also use Edge detection for tracing boundary of the lines. The original image is determined by Hough function.

Step7: Finding peaks: After computing with Hough transform, we continue to find the peaks of the Hough transform which were found by Local Maxima Finder object system that used to find local maxima in matrices.

Step8: Finding Cartesian coordinate system: the lane marker image is specified

each point uniquely in a plane by a pair of numerical coordinates for creating the Cartesian in the lines.

Step9: Drawing a polygon: on the road, we indicate the lane marker around the vehicle while driving including the front, left and right lane marker lines, and also the third lane marker line on the left or right.



(a)Solid broken

(b) Left departure and yellow solid

(c) Right departure and yellow broken

(d) Left departure and yellow solid

Figure 6. Example of texts and warning messages based on the lane road markers

Step10: Inserting text: From Drawing the polygon of lane road, we should insert the text which describes the information about the lane including, lane departure warning text such as "Right Departure" and "Left Departure", and indicate type of lane marker line such as "Yellow Broken" and "Yellow Solid".

Step11: Display the output video: After finish all the processing, we create a video player to display the output video.

3 EXPERIMENTAL RESULTS

Real-time Lane Detection for Driving System Using Image Processing Based on Edge Detection and Hough Transform has been operated by setting the webcam camera to monitor the movement of vehicle through the lanes, create a video file reader object to read input video stream, segmenting the video file to the image, converting RGB image to an intensity image and then to Y'CbCr image, creating an image filter to implement and detect edges, setting threshold to make a binary image, using Edge detection, Hough transform and Hough lines, and finally defining the analytic areas.

In this section we will explore the experimental results of the performance of the lane detection algorithm in various environments and describe its algorithm based on its process. The tested video has 320*240 image resolution. The video processing time is about 40 ms per frame on an Intel core i5 2.53 GHz processor. The algorithm achieves an average speed of 25 frames per second. We test the lane detection while driving along the lanes which have 2 types of lanes; broken line and solid line. It also has 2 colors; white and yellow lane color.

The test results are illustrated on some of the extracted video frames from 3000 frames of video clip. We proposed many lane road test conditions as shown in Figure 7. The text "Yellow Solid" uses to describe the solid lane, "Yellow Broken" uses to describe the broken lane, "Left departure" uses to notify the driver on the lane departure warning system when car crosses the left lane road as same as "Right departure" that uses to notify the driver when the car crosses the right lane road. The color of text is yellow and white for the details of lines, then red and black alternately for the departure warning words.

This test condition shows the detected lane boundaries which are highlighted by yellow, green and violet color. Yellow is the major part of lane detection color. Green and violet were used to detect others.

From the experimental results, this algorithm can detect any type of lane markers with various test conditions. The lane road in front of the vehicle is detected. Cyan polygon is used to mark the lane position. The vehicle departs from its lane, is indicated by the real-time lane

departure warning system by frame sequential display as given below:

Figure 7. Real-time lane detection for driving system Using Image Processing Based on Edge detection and Hough transform.

The results video player shows the type and color of the lane markers. It also shown the left and right lane markers and warning messages. The driver is notified by the warning message that indicates when vehicle is moving across the lane marker.

4 Conclusions

In this paper, Real-time Lane Detection for Driving System Using Image Processing Based on Edge Detection and Hough Transform is presented for helping the drivers in the lane departure decision-making by using real time lane departure warning system. The adopted lane detection method was consisted of image processing, local maxima finder, dynamical threshold, Edge Detection, Hough lines and Hough transform. Its advantages of Hough transform and Edge detection are easy to use, low cost and also effective in the field of detecting lines. Experimental results reveal the efficiency of the performance of the lane detection algorithm in various environments.

5 References

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